HANDOUT 7-1

Case Study Number 7-1 Solution

Estimating PM_{10} and $PM_{2.5}$ Emissions from Unpaved Roads

Question 1: How is the PM emission factor for unpaved roads calculated?
Answer: Equation 7-8 of the Student Manual shows the AP-42 empirical equation that is used to calculate the unpaved road emission factor. Specifically,

$$EF = [k*(s/12)*(S/30)^{0.5}]/[(M/0.5)^{0.2}] - C$$

where: EF = size specific emission factor (tons per mile)
k = empirical constant
s = surface material silt content
M = surface material moisture content
S = mean vehicle speed (mph)
C = emission factor for 1980's vehicle fleet exhaust, brake wear, and tire wear (lbs/VMT)

Question 2: What emissions from unpaved roads are accounted for by the emission factor?
Answer: Similar to the AP-42 emission factor equation for paved roads, the unpaved road emission factor equation only estimates PM emissions from resuspended road surface material. PM emissions from vehicle exhaust, brake wear, and tire wear are estimated separately, using EPA's MOBILE6, and are subtracted out of the emission factor equation.

Question 3: What is the basis of the activity data for unpaved roads?
Answer: The activity data used by the NEI for unpaved roads is state level unpaved road VMT data that is available from the Federal Highway Administration. In this case study, the VMT data are provided by a local metropolitan planning organization.

Question 4: What is the methodology for estimating monthly PM_{10} emissions from unpaved roads?
Answer: The methodology involves first using the AP-42 emission factor equation to calculate an emission factor and then applying the VMT estimate for the study area to obtain a PM_{10} emissions estimate.

Question 5: What is the value for the empirical constant in the emission factor equation?

Answer: The empirical constant k in the emissions factor estimation equation is the NEI default value of 1.8 lb/VMT for PM_{10} and 0.27 lb/VMT for $PM_{2.5}$. These values are listed in Equation 7-8 of the Student Manual.

Question 6: What is the value for the default surface material moisture content?
Answer: Table 7-5 in the Student Manual lists the NEI default values for estimating PM emissions from unpaved roads. The default for surface material moisture content is 1 percent.

Question 7: How is mean vehicle weight considered in the estimation of PM emissions from unpaved roads?
Answer: The NEI estimated PM emissions from unpaved roads by using the pre-December 2003 AP-42 emission factor equation. This equation considers mean vehicle weight. However, the December 2003 AP-42 emission factor equation does not consider mean vehicle weight and therefore, it is not used in the calculation of PM emission in this case study.

Question 8: What is your estimate for the PM_{10} emission factor for unpaved roads in the hypothetical county?
Answer: Plugging the following values into Equation 7-8 of the Student Manual results in an emission factor of 0.0256 pounds per VMT for the month of June for the study area. Note: the value for C must be converted to lbs/VMT prior to using in the equation.

k (empirical constant)	1.8 lb PM_{10}/VMT
s (surface material silt content)	7.5 percent
M (surface material moisture content)	1 percent
S (mean vehicle speed)	35 miles per hour
C (emission factor for exhaust, brake wear, and tire wear)	0.2891 grams PM_{10}/VMT

Question 9: What is your estimate of the PM_{10} emissions from unpaved roads in the county for the month of June?
Answer: The monthly emission factor (0.0256 lbs/VMT) is applied to the monthly VMT estimate of 2.964 million miles per month for the study area to obtain an estimate of PM_{10} emissions of 37.9 tons per month for the month of June.

Question 10: How would $PM_{2.5}$ emissions be estimated if this case study required that an estimate of $PM_{2.5}$ be developed?
Answer: $PM_{2.5}$ emissions are calculated in the same manner as PM_{10} emissions, with the exception that the empirical constant (k) for $PM_{2.5}$ would be used instead of the empirical constant for PM_{10}.

Question 11: How would annual PM_{10} emissions from unpaved roads be calculated?
Answer: All of the monthly PM_{10} emission estimates are summed to obtain an annual PM_{10} emission estimate.